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74. AND WHAT ABOUT NUCLEAR AND RADIOLOGICAL TERRORISM?

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1. INTRODUCTION

In the context of chemical, biological, radiological and nuclear terrorism, so-called CBRN terrorism, radiological and nuclear terrorism is widely considered as a major if not the ultimate terrorist threat for modern societies. Highly industrialized countries could be extremely sensitive to terrorist aggressions of this kind. This assertion nevertheless needs to be scrutinized. Furthermore the reasons have to be assessed why up to now there has been no record of any credible blackmail or similar acts, threatening man and environment.

This paper considers some possible answers, focusing on an analysis of the **technical feasibility** of nuclear and radiological terrorism and address further the question of the actors and their motives.

Nuclear terrorism is often associated with nuclear proliferation. Strictly speaking, nuclear proliferation deals with the spread of nuclear weapons into states which doesn't possess them.

But proliferation can also be understood as the spread of radioactive material or even nuclear explosives into the hands of non-state organizations, such as sub national terrorist or criminal organizations as well as any kind of extremist groups for sabotage, blackmail or any other destabilization or destruction purposes. This is one aspect of nuclear terrorism: the other one deals with terrorist actions against nuclear facilities or transport of nuclear material.

The US spent about 10 billion\$ in the FY 2000 to fight terrorism and, of this, about one billion alone to counter terrorism with WMD, that means Chemical, Biological and Nuclear Terrorism. Is this unprecedented effort related to an imminent and real threat? This survey on nuclear terrorism should help to clarify this question.

2. THE KNOTTY DEFINITION OF NUCLEAR TERRORISM

In the following considerations, nuclear terrorism is understood as the use of radioactive materials or even nuclear explosives as well as any terrorist actions against nuclear facilities by individuals or groups outside state control in order to create fear or terror with a credible threat.

In contrast to the numerous and effective measures of the Non-Proliferation Regime aimed against the classical nuclear proliferation, the international community has no coordinated effort to respond to a violent nuclear crime by a sub national group. An attempt to negotiate a UN convention aimed at nuclear terrorism in 1998 aborted as the participants were not able to agree on a definition of nuclear terrorism, the difficulty being not the word "nuclear" but the different perception of what "terrorism" is. To some terrorists are criminals, to others they are heroes!

3. NEW DRIVING FACTORS FOR NUCLEAR TERRORISM

▪ The emergence of a new kind of terrorists

Terrorists are principally willing to use violence in order to gain attention and have become increasingly ruthless as well as more sophisticated and operationally competent.

In addition to the traditional form of internationally organized terrorism as a means of the political fight, a new extremist threat is emerging as documented by the nerve gas attack by the Aum Sect in Tokyo, where the only goal was to create unimaginable disorder and chaos.

Although one occurrence does not constitute a trend, this act signalizes that some kind

of ethical taboo has been broken and a precedent been set. Some observers believe that the act by the Aum Sect was an aberration not likely to be repeated, others believe that the incident illustrates a fundamental change in the proliferation threat. In the context of a possible use of nuclear material or explosives, such a fact is highly disturbing.

▪ **The consequences of the break down of the Soviet Union**

Two factors have predominantly contributed to an enhanced perception of the nuclear terrorist threat in the last decade following the end of the cold war: First: the fear of a possible loss of control over nuclear material, sensitive technology, nuclear weapon related know-how in Russia and in the states of the former Soviet Union, taking into account the chaotic economical situation in these countries. The same applies to the many unemployed nuclear specialists who could be recruited by potential proliferators or terrorist organizations and accelerate their illicit nuclear activities. Second: the rise of smuggling activities with radioactive substances in the early nineties.

▪ **"Radioactive" smuggling and black-market**

The illicit trafficking of nuclear materials and other radioactive sources started after the breakdown of the Soviet Union in 1991. Previously, as a consequence of the pervasive internal security of the Soviet Union, incentives for nuclear theft were practically non-existent. In the early nineties the growth in the number of nuclear related incidents was indeed impressive. Probably due to the fact that the market definitively misses buyers, the tendency is sharply decreasing since 1994. As the "Bulletin of the Atomic Scientists" pointed out in 1997: *"The biggest problem for smugglers has been finding buyers who aren't police or journalists"*! This illicit trafficking originated principally from the nuclear industry, the nuclear research and from the nuclear medicine of the CIS, especially of Russia. Fortunately it didn't come from its military nuclear weapon complex. It is interesting, and reassuring by the way, to ascertain that only a very few incidents involve weapon usable materials. There is no verified incident involving weapon-grade material, which means fissile material directly usable for weapon purposes.

Under the auspices of the UN, the international co-operation has markedly improved, involving intergovernmental agencies, such as the World Custom Organization, Interpol, Europol, the International Civil Aviation and Marine Organizations, the International Road Transport Organization, Euratom, Minatom, etc... Nowadays the International Atomic Energy Agency (IAEA) operates a database on illicit trafficking of nuclear materials and other radioactive sources and provides furthermore help and assistance for prevention, detection, response, training and exchange of information among the member states. A similar data base is operated by the US Department Of Energy (DOE).

But there is still the disturbing facts that the number of the undiscovered smuggling cases might largely exceed the number of the discovered ones: the well known story of the "tip of the iceberg" and that the smugglers might have learn from their past mistakes!

4. THE PROTAGONISTS

The acquisition and handling of radioactive substances remain costly, difficult and dangerous. They are therefore reserved to well organized groups with large financial resources.

On the one hand, there are the traditional politically oriented terrorist organizations, possibly sponsored by a state, and on the other hand the new kind of irrationsals such as extremist and fanatic groups of all kinds, including zealots, ethnic and politically disaffected groups with a particular mention to religious minded cults.

5. THE NATURE AND THE IMPACT OF NUCLEAR TERRORISM

Basically there are three ways for terrorists to go nuclear. First: they could use fissile material, Plutonium-239 or highly enriched Uranium and try to build a so called "improvised nuclear device". Second: they could use radioactive material, disperse it in the environment with some kind of a "radiological dispersal device" in order to create a radioactive contamination. Finally they could attack a nuclear facility e.g. a nuclear power plant with the aim to induce a radioactive contamination of the environment or to steal radioactive material for purposes of radiological terrorism.

Multiple problems stand in the way of the terrorists: usually the radioactive materials needed are very well safeguarded, they are inherently dangerous and highly detectable, therefore extremely difficult to procure, they are difficult to handle and to keep secret. Thus, in any case, an act of nuclear terrorism requires a specific high-level technical expertise. Nuclear terrorism is definitively "high-tech-terrorism" in a much broader sense than B- or C-terrorism.

▪ The case of an "improvised nuclear device": The "home-made nuke"

It belongs to the category "extremely high risk - extremely low probability"

In recent years, the homemade bomb case has been largely addressed in the open literature. Experts agree that a small group of physicists, engineers, chemists, metallurgists and explosive specialists could indeed be able to build a device with a considerable nuclear yield up to one or more kilotons. The principles of construction of nuclear weapons are common knowledge today and available in the open scientific literature. The hurdles are on the engineering side: specific, sophisticated and very expensive equipment would be needed, which are furthermore under international control.

But the main, the ultimate difficulty of such a project would be the procurement of enough weapon grade fissile material, let's say at least 20 kg of Plutonium or 50 kg of highly enriched Uranium needed for a low-technology nuclear device. Despite all the cases of smuggling reported in the last years many consider that an undiscovered diversion of such quantities of fissile material is extremely unlikely or even impossible for non-state organizations.

Another option would be the use of a stolen warhead, e.g. a tactical warhead from the former Soviet Union. But these weapons have built-in technical safety and security safeguards, which could only be overridden by a specialist with specific knowledge about the particular device.

Experts agree that this is not likely to happen and that the security of the Russian nuclear weapons is healthy, according to official statements by the US government on this particular matter.

This on the short term. But what about the long term, if the economic and socio-political situation does not improve in Russia? This question remains open!

In addition to these technical limitations, there are other aspects, such as the rationale and finality of such acts, which further lower the likelihood of this extreme form of nuclear terrorism. What price at all could be asked for the blackmail of possibly killing thousand or even million of people?

Nevertheless if a terrorist organization would, contrary to all expectations, succeed in such a homemade bomb project, all scenarios one may think of would have unimaginably disastrous and possibly existential consequences. Even in the case of a malfunction of the device, a massive radioactive contamination would render the vicinity of the detonation site – probably a big city – uninhabitable for a long time.

▪ **The case of radiological terrorism**

Although still a "High-Tech"-business radiological terrorism is much easier to realize than an IND, and therefore much more likely to happen. Radioactive sources are widely in use in the civil industry, research and in the nuclear medicine with usually satisfying safety but relatively low security level. Radioactive material in the nuclear industry and of course in the military nuclear weapon complex is much better safeguarded. The procurement of radioactive substances either from the "black market" or through the theft of civil sources should not pose an unsolvable problem for terrorists with some insider knowledges. Radiological Terrorism is therefore principally feasible.

Let's consider for instance the scenario of a truck filled with tons of ANFO, an explosive made of a common fertilizer, mixed with fuel oil, doped with some kilograms of a radioactive cocktail of Pu, Cs and highly radioactive waste, remotely detonated within a gasoline storage facility near a big city. A firestorm would result, lifting the radioactive particles thousands of feet in the air and producing a downwind radioactive contamination, which could extend over square miles of the city.

There are still many open questions about the extent and actual dangerousness of such fallout. In fact, preliminary calculations shows very large quantities of radioactive material would be needed in order to contaminate significant areas or volume of air with activities leading to acute damages for man health. Such quantities could not be handled without extensive protective measures. This strongly limits the possible quantities involved in an act of radiological terrorism, which thus remains a local event, whose extension is comparable to those of an act of chemical terrorism. Despite these limitations any act of nuclear terrorism would definitively create an unprecedented psychological and finally economical trauma.

A final remark

Conventional High Explosives and weapons, or even B- or C-agents would be easier and cheaper to produce or procure and to use: therefore probably a better choice for terrorists!

▪ **The case of the attack or of the sabotage of a nuclear facility**

There are different kind of nuclear facilities, that could be targeted by terrorists: first of all probably nuclear power plants (NPP) but all kind of storage facilities for military and civilian nuclear material and radioactive waste, reprocessing plants for nuclear fuel, uranium enrichment plants and nuclear research reactors. Although not a "facility" the transport of nuclear material belong to this category too.

As an example lets consider the case of a nuclear power plant.

Terrorists could attack a NPP in order to provoke a release of radioactivity in the environment, some kind of an ultimate radiological terrorism or terrorists could steal nuclear material such as unirradiated or irradiated and therefore highly radioactive spent fuel with the aim to extract later the fissile material contained in the rods for any purposes of radiological terrorism.

Compared to other civilian industrial facilities NPP are extremely well protected. To some extent a NPP can be in fact compared to a military fortress. First there are all the safety measures designed to prevent any release of radioactivity in the environment in the case of a malfunction of the plant. Reinforced concrete and steel containment structures coupled with redundant safety and shutdown systems are designed to permit the facility to further withstand the impact of earthquakes, hurricanes, tornados and flood as well as airplane crashes. Second: in addition to these extensive safety measures there are the quite as much extensive security measures taken to protect the facility against any sabotage or malevolent criminal or terrorist actions. The physical protection of a NPP bases according to the

recommendations of the IAEA on the concept of a defense in depth that requires an adversary to overcome multiple obstacles in order to achieve his objective. The adversary threat takes into account the attackers from outside the plant as well as insiders, who could help the outsiders. Third: all nuclear material in a NPP is comprehensively safeguarded, according to the prescriptions of the IAEA. And finally: with the exception of the unirradiated fuel all other nuclear material stored in the plant is extremely radioactive and dangerous to handle.

Taking into account the safety and security aspects as well as the self-protective characteristics of radioactive material it is difficult to imagine a credible scenario of a successful terrorist attack or sabotage of a NPP leading to a important release of radioactivity in the environment or to a theft of radioactive material. Actually the case of a terrorist attack against a NPP is characterized by its very low feasibility and therefore by a corresponding low probability of occurrence

So much for the "Western-style" NPP's. What about the NPP in the countries of the former Soviet Union? Their safety stays on a lower level. A containment is usually not provided and cannot be installed afterwards. In the Soviet Union the physical protection was assured essentially by strong police, if necessary also by military forces. This is no more the case or at least strongly reduced. There were almost no technical security measures foreseen. Today this lack of security measures makes these "Eastern-style"-NPP much more vulnerable to any terrorist actions

Despite this low feasibility of terrorist actions, at least against NPP of western concept, the impact of a successful attack could be tremendous. In the worst case it could reach "Tschernobyl-like" dimensions. Even in the case of an attack on a NPP, which doesn't lead to a release of radioactivity in the environment, the psychological effects on the public would be enormous and even damaging for the whole nuclear industry.

6. ARE THERE ANY OPTIONS?

Talking about terrorism in general and about nuclear terrorism in particular, one should not forget that all the choices and options where and when to do what, are in the hands of the terrorists. In the best case, it would be blackmail, linked to an ultimatum which would leave some time for countermeasures, if any, or, more probably, time for evacuation. But terrorists could act without warning, as in Tokyo or Oklahoma.

Real options in the case of a credible nuclear blackmail or an attack are thus very limited. A long term and internationally coordinated prevention seems to be the only way to counter the threat.

The international terrorism, as well as the illicit traffic and smuggling of radioactive substances must be intensively opposed and fought. Fissile nuclear material, including the "civilian" one, should be better controlled, especially in the states of the former Soviet Union. The cooperation on the technical level with already existing organizations must be extended. (For instance, the US have special units trained to handle nuclear emergencies and acts of nuclear terrorism. Such "Nuclear Emergency Search Teams" (NEST) have special technical equipment for identifying unknown radiation sources, might be able to defuse nuclear weapons and decontaminate irradiated areas. NEST can move in the US and all over the world on very short notice.) Governments must be prepared and trained to respond to such extreme situations, information concepts for the population and relations with the media must be elaborated and emergency measures and emergency management foreseen. Finally, since radioactivity is a highly confusing and emotional issue for the public, the consequences following a nuclear event might extend to widespread civil disorder and public health problems, fear, and distrust because of unfamiliarity with the risks and effects of radiation. Therefore prevention includes public education and understanding radiological hazards.

7. AN ASSESSEMENT OF THE RISKS OF NUCLEAR TERRORISM

Technically speaking the risk of an event is defined as the product of the probability of occurrence of the event considered and the effects or damages it produces. The probability of occurrence can be assessed by statistical methods e.g. for tornados, falls of meteorites etc. or by an analysis of the feasibility respectively of the occurrence of the event, the latest being relevant for an assessment of nuclear terrorism. The effects or damages are determined by selecting different criteria and trying to quantify the effects. In the qualitative risk assessment of terrorist presented in the **Figure 1** the criteria chosen for the effects are: the area affected, the health effects on man, the damages on the environment and the effects on economics. The psychological effects are usually not included in a risk assessment, but are of essential importance in such a consideration since radioactivity is a highly emotional issue for the public.

Case	Technical feasibility /Probability of occurrence (P)	Effects/Damages (E)				Risk (R)
		Area affected	Man	Environment /Economics	Psychological	
IND-case (home made bomb)	Extremely low	large ($>50\text{km}^2$)	very large to catastrophic	disastrous	traumatic	extremely low
Radiological terrorism	still difficult but feasible	mainly local	small to medium	large, especially on economics	in any case (very large)	medium
Attack or sabotage of a nuclear facility	Security makes it (very) difficult	very large ($> 100\text{km}^2$)	limited	very large	tremendous	very low

Figure 1: Qualitative assessment of the risks associated with acts of nuclear terrorism

Despite the fact that the damages of a successful IND-case would be disastrous the risk is essentially determined by the extremely low technical feasibility and therefore extremely low probability of occurrence. An identical conclusion can be drawn for the case of an attack or a sabotage of a nuclear facility, the difference between "extremely low" and "very low" is gradual and a question of interpretation! Although still difficult and an high-tech-business radiological terrorism is incomparably more feasible than the other cases. The scale of possible effects is much lower but the incidence on the economics could be large, that means very costly and the psychological effects on the public are guaranteed and in any cases important. Radiological Terrorism represents indeed the dominant threat in the context of nuclear terrorism.

8. IS NUCLEAR TERRORISM THE ULTIMATE FORM OF TERRORISM?

As a tentative conclusion it can be stated that nuclear terrorism could indeed be the ultimate form of terrorism, but it's not likely to happen. Nevertheless, since the probability of nuclear terrorism, especially of radiological terrorism, is low but not zero, the theme has to be addressed very seriously by the international community.